

II. Rejection of claim 3

The Examiner has rejected independent claim 3 under 35 U.S.C. § 103(a) over Adachi (JP 11-354,769). In particular, the Examiner has indicated that (emphasis added):

With regard to claim 3, Adachi et al. discloses an optoelectronic device comprising an optical device system having one or more optical devices 24 and a solderable metallization pattern having a spatial arrangement with respect to the one or more optical devices 24; an optical lens system 26 comprising one or more optical lens 27 and a device bonding surface 21 supporting a solderable metallization pattern 23 having a spatial arrangement with respect to the one or more optical lenses 27; wherein the one or more lenses 27 are recessed below the device bonding surface 21; a plurality of solder bumps 25 disposed between the metallization patterns of the optical device system and the optical lens system 26; wherein the plurality of solder bumps 25 bond the optical device 24 to the device bonding surface 21 with the one or more optical devices 24 aligned with the one or more optical lens 27. Note figures 1, 2, 5, 7 of Adachi et al.

Contrary to the Examiner's assertion, however, the lens 27 in Adachi's image sensor is not recessed below the device bonding surface of an optical substrate. The Examiner identifies as the device bonding surface the surface of the printed wiring board 21 that faces the image sensor element chip 24. The lens 27, however, is not recessed below that surface of printed wiring board 21. Indeed, lens 27 is formed as part of a structure 28 that is attached to a substrate 29 that, in turn, is attached to the surface of the printed wiring board that is opposite the device bonding surface. When read in the light of applicants' specification, there is no reasonable interpretation of the work "recessed" that could be used to argue that Adachi's lens 27 is recessed below the surface of the printed wiring board 21 that faces the image sensor element chip 24.

For at least these reasons, the Examiner's rejection of claim 3 under 35 U.S.C. § 103(a) over Adachi should be withdrawn.

New claim 28 incorporates the features of independent claim 3 and therefore is patentable for at least the same reasons.

III. Rejection of claim 11

The Examiner has rejected independent claim 11 under 35 U.S.C. § 103(a) over Gratrix (EP 649,041). In particular, the Examiner has indicated that (emphasis added):

Gratrix does not disclose the metallization patterns of the optical device system and the optical lens system. However, it would have been obvious to one of ordinary skill in the art to form the optoelectronic device of Gratrix having the metallization patterns of the optical device system and the optical lens system, because such structure is conventional in the art for bonding the solder bump to the optical device substrate or the optical lens substrate.

Contrary to the Examiner's assertion, however, it would not have been obvious to one of ordinary skill in the art at the time of the invention to modify Gratrix's microelement assembly by incorporating metallization patterns on the surfaces 14, 22 of first and second substrates 12, 20 because such a modification would amount to extra unnecessary steps that would not serve any useful purpose in the context of Gratrix's kinematical interfacing approach. Gratrix explains that the kinematic protrusions 30 and the kinematic mounting receptacles may be formed directly on the opposing surfaces 14, 22 of substrates 12, 20 using a photolithographic process. Gratrix further explains that (col. 5, lines 22-27):

Because of the accuracy inherent with a process such as photolithography, the protrusions 30 and the kinematic mounting receptacles 32 are thus very accurately aligned with each other. Further, such accurate alignment is quite repeatable.

Interposing metallization patterns between the substrates 12, 20 and the kinematic protrusions 30 and mounting receptacles 32 would not increase alignment accuracy because Gratrix's approach already enjoys the full alignment accuracy benefits of photolithographic processing techniques. Indeed, such a modification would increase fabrication costs because of the additional photolithographic steps that would be required and the additional material requirements. In addition, such a modification would increase the complexity of the controlling the separation distance (h) between the opposing surfaces 14, 22 of substrates 12, 20. Accordingly, there would not have been any motivation for one of ordinary skill in the art at the time of the invention to modify Gratrix in the way that the Examiner has proposed.

For at least these reasons, the Examiner's rejection of claim 11 under 35 U.S.C. § 103(a) over Gratrix should be withdrawn.

New claim 29 incorporates the features of independent claim 11 and therefore is patentable for at least the same reasons.

IV. Rejection of claims 4-10, 12, and 21-24

A. Independent claim 4

The Examiner has rejected claim 4 under 35 U.S.C. § 103(a) over Adachi. The Examiner has asserted that Adachi's "optical lens system 26 comprises an optical substrate 29 incorporating the one or more lenses 27. Contrary to the Examiner's assertion, however, Adachi's substrate 29 does not incorporate one or more lenses. Instead, Adachi's substrate 29 is attached to a separate structure 28 that incorporates lens 27. There is no teaching or suggestion in Adachi that substrate 29 should be modified to incorporate lens 27. Indeed, such a modification may defeat Adachi's objective to achieve a sufficient separation distance between image sensor element chip 24 and lens 27.

For at least these reasons, the Examiner's rejection of independent claim 4 under 35 U.S.C. § 103(a) over Adachi should be withdrawn.

B. Dependent claims 5-10, 12, and 21-24

Dependent claims 5-10, 12, and 21-24 incorporate the features of independent claim 4 and, therefore, these claims are patentable for at least the same reasons explained above. Dependent claims 5, 6, 21-24 are patentable for the following additional reasons.

Dependent claim 5 requires that the optical substrate be bonded to the spacer substrate by a wafer bonding process. Adachi does not teach or suggest such a device structure. Indeed, neither substrate 29 nor printed wiring board 21 is a wafer and, therefore, such elements are not susceptible to bonding by a wafer bonding process.

Dependent claim 6 requires that the optical substrate be bonded to the spacer substrate by a flip-chip solder bonding process. Adachi does not teach or suggest such a device structure.

Dependent claim 21 requires the one or more optical lenses to be incorporated into the device bonding surface. Adachi does not teach or suggest such a structure. Indeed, as explained above, Adachi's device bonding surface corresponds to the surface of the printed wiring board that faces the image sensor element chip 24. Accordingly, there is no obvious way to modify Adachi so that optical lens 27 could be incorporated into the device bonding surface. Furthermore, such a modification may defeat Adachi's objective to achieve a sufficient separation distance between image sensor element chip 24 and lens 27.

Dependent claim 22 requires that the one or more optical lenses be recessed below the device bonding surface. Adachi does not even hint at such a structure, as explained above in connection with independent claim 3.

Dependent claim 23 requires multiple optical lenses that are cooperatively arranged in optical alignment with multiple respective optical devices. Adachi does not teach or suggest such a feature.

Dependent claim 24 requires multiple optical devices that are arranged for optical communication through multiple respective spacer substrate apertures. Adachi does not teach or suggest such a feature.

For at least these additional reasons, the Examiner's rejection of dependent claims 5, 6, and 21-24 under 35 U.S.C. § 103(a) over Adachi should be withdrawn.

V. Rejection of claims 13 and 25-27

A. Independent claim 13

The Examiner has rejected claim 13 under 35 U.S.C. § 103(a) over Adachi. Claim 13 has been amended and now requires that the spacer substrate be a semiconductor substrate. Adachi does not teach or suggest such a feature. Moreover, based on Adachi's teaching, one of ordinary skill in the art at the time of the invention would not have contemplated that printed wiring board 21 could have been replaced by a semiconductor substrate.

For at least this reason, the Examiner's rejection of independent claim 13 under 35 U.S.C. § 103(a) over Adachi should be withdrawn.

New claim 30 incorporates the features of independent claim 13 and therefore is patentable for at least the same reasons.

B. Dependent claims 25-27

Dependent claims 25-27 incorporate the features of independent claim 4 and, therefore, these claims are patentable for at least the same reasons explained above. Dependent claims 25-27 are patentable for the following additional reasons.

Dependent claim 25 requires that the one or more optical lenses be recessed below the device bonding surface. Adachi does not even hint at such a structure, as explained above in connection with independent claim 3.

Dependent claim 26 requires multiple optical lenses that are cooperatively arranged in optical alignment with multiple respective optical devices. Adachi does not teach or suggest such a feature.

Dependent claim 27 requires multiple optical devices that are arranged for optical communication through multiple respective spacer substrate apertures. Adachi does not teach or suggest such a feature.

For at least these additional reasons, the Examiner's rejection of dependent claims 25-27 under 35 U.S.C. § 103(a) over Adachi should be withdrawn.

VI. Conclusion

For the reasons explained above, all of the pending claims are now in condition for allowance and should be allowed.

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APPENDIX

Marked-up versions of the amendments made by the Response to the Office action dated November 5, 2002, are presented below.

In the claims:

13. (Amended) An optoelectronic device, comprising:
an optical lens system comprising a lens substrate supporting one or more optical lenses, and a semiconductor spacer substrate defining one or more apertures therethrough;
and
an optical device system comprising a device substrate supporting one or more optical devices;
wherein the lens substrate is bonded to the spacer substrate and the spacer substrate is bonded to the device substrate with the one or more optical lenses, the one or more optical apertures and the one or more optical devices held together in registered alignment.
23. (Amended) The optoelectronic device of claim 4, wherein multiple optical lenses are cooperatively arranged in optical alignment with multiple respective [each] optical devices [device].
24. (Amended) The optoelectronic device of claim 8, wherein multiple optical devices are arranged for optical communication through multiple respective [each] spacer substrate apertures [aperture].
26. (Amended) The optoelectronic device of claim 13, wherein multiple optical lenses are cooperatively arranged in optical alignment with multiple respective [each] optical devices [device].
27. (Amended) The optoelectronic device of claim 13, wherein multiple optical devices are arranged for optical communication through multiple respective [each] spacer substrate apertures [aperture].